MUFFLER FOR COMPRESSOR

BACKGROUND OF THE INVENTION

The present invention relates to a compressor, for example, for use in an automobile climate control system, and more particularly to substantially reducing pulsations of refrigerant in compressors.

A typical compressor includes a swash plate double-headed piston type disclosed in, for example, Japanese Unexamined Patent Publication No. 8-261147. In this type of compressors, a front housing is secured to a front end face of a front cylinder block through a valve plate, and a rear housing is secured to a rear end face of a rear cylinder block through another valve plate. In each housing, a suction chamber and a discharge chamber are defined. The cylinder blocks and the housings constitute a housing body. A drive shaft is rotatably supported in center bores of both the cylinder blocks. A plurality of cylinder bores is formed in the cylinder blocks around the drive shaft, and a piston is accommodated in each of the cylinder bore. A crank chamber is formed between the front and rear cylinder blocks. A swash plate is fixed on the drive shaft in the crank chamber and is in contact with each piston through a pair of shoes. As the drive shaft is rotated, the rotation of the swash plate is transmitted to each piston through the shoes, and each piston is reciprocated in the cylinder bores. At a rear end of the drive shaft in the cylinder block, a muffler chamber is formed. The muffler chamber communicates with a discharge chamber in the rear housing through a passage formed in the rear housing. With the reciprocating motion of the piston, the refrigerant in suction chambers opens flap suction valves and is drawn into the cylinder bores. Also with the reciprocating piston, the compressed refrigerant in the cylinder bores opens flap discharge valves and is discharged to the discharge chambers. The

refrigerant in the discharge chambers is discharged to an external refrigerant circuit through the muffler chamber. At this time, the muffler chamber functions to reduce pulsations of the refrigerant. Consequently, noise and vibrations are suppressed.

Japanese Unexamined Utility Model Publication No. 63-143776 discloses a double-headed piston type swash plate compressor with an external muffler. The compressor has an external muffler chamber that is connected to discharge chambers through discharge passages formed between the cylinder bores in the cylinder block and is isolated from a crank chamber. The compressor has almost the same construction as the swash plate compressor of a double-headed piston type according to Japanese Unexamined Patent Publication No. 8-261147 except for the external muffler chamber which increases the compressor in size. Accordingly, the pressure pulsations are reduced as the double-headed piston type swash plate compressor according to Japanese Unexamined Utility Model Publication No. 63-143776.

As disclosed in Japanese Unexamined Patent Publication No. 8-110104, when carbon dioxide or CO_2 is applied as a refrigerant, refrigerant pressure of CO_2 is more than five times of that of freon. At this time, pressure pulsations of the discharge gas increase because of the high-pressure refrigerant. To suppress the vibrations and noise due to the pressure pulsations, a muffler chamber must be increased in capacity. On the other hand, when CO_2 is applied as a refrigerant, compressor housing walls need to have enough thickness to endure the high-pressure refrigerant. The high-pressure resistant walls make it difficult to yield a high capacity in a muffler chamber. Accordingly, pressure pulsations are not satisfactorily suppressed.

In the compressor according to Japanese Unexamined Patent

Publication No. 8-261147, a muffler chamber is arranged at the rear of the drive shaft in a cylinder block. When CO_2 is applied as a refrigerant in a single-headed piston type compressor, following problems will occur. In general, the drive shaft is pressed to a front side when discharge pressure is introduced into the muffler chamber. In the single-headed piston type compressor, the drive shaft is always pressed frontward by compressive reaction force through the pistons and the swash plate. Thus, a large load acts on a thrust bearing arranged between a rotor and the front housing. Such an excessive load shortens the life of the thrust bearing. In particular, when CO_2 is applied as a refrigerant, the compressive reaction force and the pressure in the muffler chamber on the drive shaft become higher than when freon is applied as a refrigerant. Accordingly, the load acting on the thrust bearing is further increased.

In addition, the rear side of the drive shaft with respect to the swash plate is shortened because the muffler chamber occupies the same space. That is, the drive shaft portion supported in the cylinder block is not only limited in length, but also the distance between the swash plate and a radial bearing is reduced. Therefore, large force acts on the radial bearing. Accordingly, such a compressor needs a radial bearing in high strength.

As described above, when the muffler chamber is arranged near the rear side of the drive shaft, the compressor tends to have interference on the radial bearing. That is, when CO_2 is applied as a refrigerant with the same capacity of the muffler chamber as the conventional compressor, it is desired that noise and pressure pulsations should be improved.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a compressor in which pressure pulsations can be reduced even when a compressor has high-pressure refrigerant such as CO_2.

To achieve the above object, the present invention has following features. A compressor includes a cylinder block, a chamber housing, a drive shaft, a piston, and a cam mechanism. The cylinder block has a plurality of cylinder bores and a muffler chamber. The muffler chamber is formed within said cylinder block in a space between the cylinder bores. The chamber housing is secured to one end of the cylinder block and has at least a pair of a suction chamber and a discharge chamber located near each of the cylinder bores. The discharge chamber communicates with the muffler chamber. The drive shaft is rotatably supported in the cylinder block. The piston is disposed in each of the cylinder bores for compressing gas to generate compressed gas. The cam mechanism converts rotation of the drive shaft to reciprocating movement of the piston.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a diagram in a cross-sectional view illustrating a first embodiment of the compressor according to the present invention;

Fig. 1(a) is an enlarged cross-sectional view as seen from line

Ia-Ia in Fig. 1;

Fig. 1(b) is an enlarged cross-sectional view as seen from line Ib-Ib in Fig. 1; and

Fig. 2 is a diagram in a cross-sectional view illustrating a second embodiment of the compressor according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of the compressor equipped with an improved muffler according to the present invention will now be described with reference to Figs. 1, 1(a) and 1(b).

As shown in Fig. 1, a swash plate 11 functioning as a cam mechanism is accommodated in a swash plate housing 12. The swash plate housing 12 is secured between one end of a cylinder block 13 and a motor housing 15. A chamber housing 14 is secured to the other end of the cylinder block 13. The motor housing 15, the swash plate housing 12, the cylinder block 13 and the chamber housing 14 are fixedly bolted by a plurality of bolts 10 which are not shown in Fig. 1 but in Figs. 1(a) and 1(b). A drive shaft 16 is rotatably supported in the cylinder block 13 and the motor housing 15 respectively by radial bearings 17 and 18. In detail, the drive shaft 16 extends through a support hole 132 formed in the cylinder block 13, and the radial bearing 17 placed in the support hole 132 supports the drive shaft 16. The drive shaft 16 extends through a support hole 151 formed in the motor housing 15, and the radial bearing 18 placed in the support hole 151 supports the drive shaft 16 which extends through an end wall 121 of the swash plate housing 12. The swash plate 11 is fixedly placed on the drive shaft 16 in the swash plate

housing 12.

On an inner surface of the motor housing 15, a stator 19 is mounted. Inside the motor housing 15, a rotor 20 is mounted on the drive shaft 16. For example, the drive shaft 16 and the rotor 20 may be fixed to each other by press-fitting or key-fitting. The rotor 20 rotates by generating electricity to the stator 19. The drive shaft 16 rotates integrally with the rotor 20. The stator 19 and the rotor 20 constitute a motor 21.

As shown in Fig. 1(b), a plurality (four in the embodiment) of cylinder bores 131 is formed in the cylinder block 13. The cylinder bores 131 are arranged around the drive shaft 16 at an equal distance. A single-headed piston 22 is accommodated in each of the cylinder bores 131.

As shown in Fig. 1, the piston 22 is engaged with the swash plate 11 through a pair of shoes 23. Accordingly, as the drive shaft 16 is rotated, the movement in the axial direction at a distal end of the swash plate 11 is transmitted to each piston 22 through the shoes 23, and consequently, the piston 22 is reciprocated in the cylinder bore 131.

Still referring to Fig. 1, a thrust bearing 29 is arranged between a boss portion 111 of the swash plate 11 and the end wall 121 of the swash plate housing 12 to surround the drive shaft 16. The reciprocating movement of the piston 22 produces compressive reaction force. The compressive reaction force is received by the end wall 121 through the pistons 22, the shoes 23, the swash plate 11 and the thrust bearing 29. A thrust bearing 30 and a spring 31 are arranged between the boss portion 111 and the radial bearing 17 in the support hole 132 to surround the drive shaft 16. The spring 31

urges the swash plate 11 and the drive shaft 16 towards the motor housing 15 through the thrust bearing 30. The urging force of the spring 31 is received by the end wall 121 through the thrust bearing 30, the swash plate 11 and the thrust bearing 29.

As shown in Fig. 1, a valve plate 24 and a suction valve plate 25 are arranged between the chamber housing 14 and the cylinder block 13. In the chamber housing 14, a suction chamber 142 and a discharge chamber 143 are defined. A discharge valve plate 26 and a retainer plate 27 are caulked to the valve plate 24 in the discharge chamber 143 by pins 28 which are not shown in Fig. 1 but in Fig. 1(a). On the valve plate 24, suction ports 241 are formed so that the suction chambers 142 and the cylinder bores 131 are connected with each other. On the valve plate 24 and the suction valve plate 25, discharge ports 242 are formed so that the discharge chambers 143 and the cylinder bores 131 are connected with each other. On the suction valve plate 25, suction valves 251 are formed. On the discharge valve plate 26, discharge valves 261 are formed. The suction valves 251 open and close the suction ports 241. The discharge valves 261 open and close the discharge ports 242.

Still referring to Fig. 1, during a suction stroke of the piston 22 (the movement from right to left), refrigerant in the suction chamber 142 pushes away the suction valves 251 on the suction ports 241 and is drawn into the cylinder bores 131. During compression and discharge strokes of the piston 22 (the movement from left to right), the refrigerant drawn into the cylinder bores 131 is compressed in the cylinder bores 131, and pushes away the discharge valves 261 on the discharge ports 242 and is discharged to the discharge chambers 143. The retainer plate 27 regulates the opening degree of the discharge valves 261 by the contact therebetween. The refrigerant discharged to the discharge chambers 143 is discharged to an external refrigerant

circuit (not shown) through a discharge passage 145 which is also shown in Fig. 1(a).

Referring to Fig. 1, 1(a) and 1(b), a muffler chamber 34 includes at least one recess. A first recess 134 which is opened to the chamber housing 14 is formed in the cylinder block 13 and is isolated from the support hole 132 in which the drive shaft 16 is inserted and the cylinder bore 131. On the other hand, a second recess 144 which is opened to the cylinder block 13 is optionally formed in the chamber housing 14. A muffler port is formed on the valve plate 24 and on the suction valve plate 25 to communicate the first recess 134 with the second recess 144. Both the first and second recesses 134 and 144 are connected via the muffler port when the cylinder block 13 is integrally secured to the chamber housing 14. Thus, the muffler chamber 34 is formed to include the first and second recesses 134 and 144.

As shown in Fig. 1(a), the discharge passage 145 crosses the muffler chamber 34. The muffler chamber 34 communicates with a pair of the discharge chambers 143 and the external refrigerant circuit through the discharge passage 145. That is, the discharge chamber 143 receives refrigerant discharged from an adjacent pair of the cylinder bores 131, and the muffler chamber 34 receives the refrigerant from the pair of the discharge chambers 143. Then, the muffler chamber 34 discharges the interflowed refrigerant to the external refrigerant circuit as indicated by an arrow. The refrigerant in the external refrigerant circuit returns to the suction chamber 142 through a condenser, an expansion valve and an evaporator in the external refrigerant circuit. The external refrigerant circuit and the compressor constitute a refrigerant circuit for use in an automobile climate control system. In this embodiment, CO_2 is utilized as a refrigerant.

In the embodiment of the present invention, the following effects are obtained.

(1) The refrigerant discharged from the discharge chamber 143 expands in the muffler chamber 34. Thus, pressure pulsations of the refrigerant are substantially reduced. Accordingly, vibrations and noise due to the pressure pulsations are also substantially reduced.

(2) The muffler chamber 34 is formed not only in the cylinder block but also in the chamber housing 14 to extend from the cylinder block 13. Thus, the capacity of the muffler chamber 34 is increased. Accordingly, pressure pulsations are substantially reduced even in a compressor having high-pressure refrigerant such as CO_2.

(3) The muffler chamber 34 is arranged in a space between the cylinder bores 131 and is surrounded by three bolts 10. Accordingly, the space between the cylinder bores 131 is effectively used, and the muffler chamber 34 endures the high-pressure refrigerant effectively by the bolts 10.

(4) The muffler chamber 34 is arranged so as to be isolated from an axis of the drive shaft 16. Thus, the length of the drive shaft 16 in the axial direction is not reduced by the muffler chamber 34. That is, the distance between the swash plate 11 and the radial bearing 17 is increased by extending the drive shaft 16 in the axial direction, and the load acting on the radial bearing 17 is reduced. Furthermore, in this construction when a motor is integrally arranged with a compressor, the compressor with the motor is reduced in length in the axial direction.

A second preferred embodiment of the compressor equipped with an improved muffler according to the present invention will now be described with reference to Fig. 2.

In the embodiment, a compressor is a double-headed piston

type and pistons compress gas at both ends of cylinder bores. However, certain other elements of the second embodiment are substantially identical to those of the first embodiment, and these substantially identical elements are referred by the same reference numbers. A front housing 114, a first cylinder block 113, a second cylinder block 13 and a rear housing 14 are fixedly bolted by a plurality of bolts 10 (only one bolt is illustrated in Fig. 2), and these elements construct a housing body. A drive shaft 16 is rotatably supported in the housing body. A swash plate 11 is fixedly placed on the drive shaft 16 between the first and second cylinder blocks 113 and 13. The second cylinder block 13 has a plurality of cylinder bores 131, and a piston 22 is disposed in each of the cylinder bores 131. A muffler chamber 34 includes at least one recess. A first recess 134 is adjacent to the rear housing 14 and is formed in the second cylinder block 13. On the other hand, a second recess 144 is adjacent to the second cylinder block 13 and is formed in the rear housing 14. Thus, the muffler chamber 34 in the first embodiment is duplicated at both sides of the cylinder bore 131 in the second embodiment.

Still referring to Fig. 2, the second preferred embodiment of the compressor with an internal muffler according to the present invention will be described below without departing from the spirit or scope of the invention. All the discharge chambers 143 are connected to the muffler chamber 34 so that all the discharge chambers 143 communicate therebetween. A plurality of the muffler chambers 34 is formed to span between the cylinder block 13 and the chamber housing 14. Capacity of the muffler chamber 34 is further increased, and the muffler operation is effectively performed.

Referring to Figs. 1, 1(a), 1(b) and 2 in the first and second preferred embodiments, the drive shaft 16 is operatively connected to a vehicle engine as an outer drive source through a clutch mechanism

such as a magnetic clutch. The compressor according to the present invention is applied to an air conditioner or a refrigerant cycle whose refrigerant is other than CO_2. The present invention is applied to a wobble plate type compressor or a variable displacement type compressor or the like that has different construction from the compressor according to the above described first embodiment. That is, the compressor has an inclinable swash plate which integrally rotates with the drive shaft 16, and the variable rotational movement of the swash plate is converted to reciprocating movement of a single-headed piston through a pair of shoes. According to the present invention as described in the above preferred embodiments, pressure pulsations are substantially reduced without increasing the size of a compressor, even when the compressor has high-pressure refrigerant such as CO_2. Accordingly, noise and vibrations due to the pressure pulsations are substantially reduced.

The present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.